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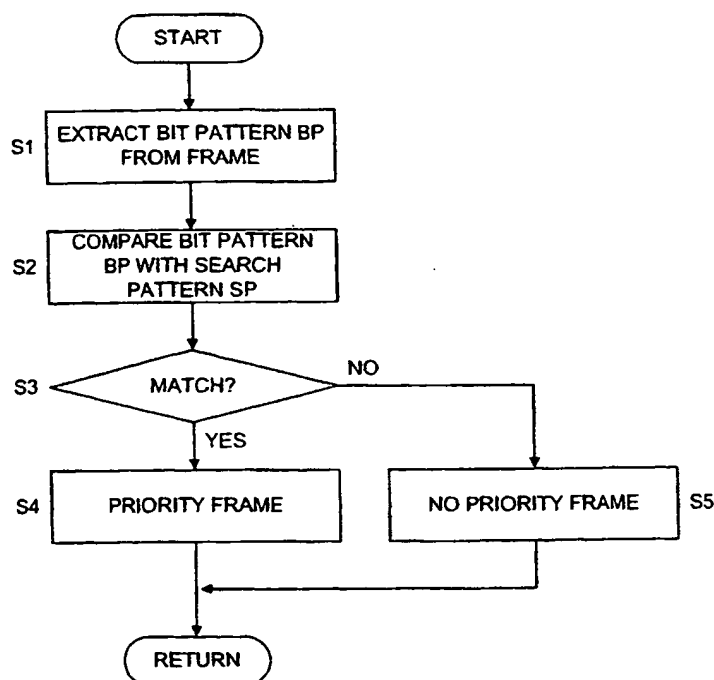
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(54) Title: **A METHOD FOR CONTENTION FREE TRAFFIC DETECTION**



(57) Abstract: The invention discloses a method for detecting priority of data frames comprising the steps of extracting (S1) a bit pattern from a predetermined position in a frame, comparing (S2, S3) said extracted bit pattern with a search pattern, and identifying (S4) said received frame as a priority frame in case said extracted bit pattern (BP) matches with said first search pattern (SP). By this method, the priority of a data frame can easily be detected. The invention also proposes a corresponding device for detecting

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A METHOD FOR CONTENTION FREE TRAFFIC DETECTION

Field of the invention

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The present invention relates to a method and a device for detecting priority of data frames in a network.

10 BACKGROUND OF THE INVENTION

This invention relates in general to the field of telecommunications, more precisely to Wireless Local Area Networks (WLAN) and Electrical and Electronics Engineers
15 (IEEE) 802.11 WLAN standard.

The IEEE 802.11 Wireless Local Area Network specification specifies a so-called Contention Free Period (CFP), which is a period of transmission time that is free from the
20 normal contention based airtime reservation. The length and duration of CFP are configurable parameters in Access Point (AP), so that the start of CFP is repeated after one or more Delivery Traffic Indication Message (DTIM) intervals (see IEEE 802.11 standard). The CFP and its
25 relationship to the so-called Content Period (CP) is schematically illustrated in Fig. 12. As can be seen, a CFP repetition interval contains a Content Free Period (CFP) and a Content Period (CP). Each CFP begins with a beacon frame that contains a DTIM element.

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The purpose of this CFP is that it can be used for delivering high priority traffic, which has higher real time requirements than normal traffic. The CFP is controlled by the so-called Point Coordination Function
35 (PCF) in an Access Point (AP). The standard specifies the

PCF operation in basic level, but does not specify how the PCF should be controlled or how some traffic should be identified as high priority traffic. These things are considered to be out of the scope of the standard.

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Information within data frames is marked as having a high priority by using certain fields in some protocol frames or headers. However, the Access Point (AP) usually processes only frames on the Medium Access Control (MAC) layer such that the AP can not easily access information regarding the priority of certain data blocks within the frames, since this information is processed in higher layers.

15 Thus, for getting priority information, conventionally the frames which are to be transmitted through an Access Point (AP) had to be searched for these fields which indicate the priority state of the actual data frame. This means that in all frames all fields had to be
20 checked, all the headers had to be analyzed, starting from the outer most headers, until the right field in the header had been found.

Since all frame headers are parsed when detecting
25 priority, this measure has a high reliability.

However, this measure is very complex, takes a long time and requires a large processing amount. Furthermore, the traffic transferred in WLAN can be practically
30 everything, including complex tunneling protocols. Therefore, all the frame headers and protocols which can be included in the data frames transmitted via the network has to be known. Hence, the amount of information needed for identifying the data is huge. This huge amount
35 of information is typically too heavy to handle in quite

small and low price equipment like WLAN access points (AP).

In addition, it has to be considered that every time new
5 protocols are introduced, the access point has to be updated, at least by software updates. This is also required in case protocols already used are changed.

Thus, conventionally such a transmission differentiation
10 based on priority was not conducted at all. That is, the existing systems according to the IEEE 802.11 standard do not separate traffic based on priority. In these conventional systems, the Content Free Period (CFP) is only used to deliver traffic from the Access Point (AP)
15 to stations, treating all frames equally.

SUMMARY OF THE INVENTION

20 Therefore, the object underlying the invention resides in removing the above drawbacks of the prior art and to provide a method by which priority traffic can easily be distinguished from normal traffic without the need of a complex processing.

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This object is solved by a method for detecting priority of data frames in a network according to claim 1.

In particular, the method comprises the steps of
30 extracting a bit pattern from a predetermined position in a frame, comparing the extracted bit pattern with a search pattern, and identifying the received frame as a priority frame in case the extracted bit pattern matches with the first search pattern.

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Alternatively, the above object is solved by a device for detecting priority of data frames in a network according to claim 12.

- 5 In detail, the device comprises a receiving means for receiving data frames, an extracting means for extracting a bit pattern from a predetermined position of a data frame, and a comparing means for comparing the extracted bit pattern with a predetermined search pattern, and an
10 identifying means for identifying the received frame as a priority frame in case the extracted bit pattern matches with the first search pattern.

Thus, a priority which is defined in a higher-level layer
15 can easily be detected by comparing a corresponding bit pattern with a search pattern without further processing of the received frame. By the method and the device according to the invention, simply a bit pattern is extracted at a position in the frame, where the priority
20 information is known to be located. This bit pattern is compared with a search pattern which corresponds to that bit pattern, which would be located at the above position in case that a priority is set for the actual frame. Thus, it is not necessary to process and analyze the
25 received frame, i.e., to process higher-level layers in order to obtain priority information.

Hence, when adopting the IEEE 802.11 WLAN standard, the priority can be detected in the Medium Access Control
30 (MAC) layer which is a low-level layer. That is, the method can easily find higher priority traffic from the stream of MAC layer frames. Therefore, the method does not need any knowledge of the upper layer protocols.

Thus, according to the method of the invention, certain traffic can be defined to have higher priority than other when it is handled in an IEEE 802.11 WLAN Access Point (AP). The method is designed so that it is as lightweight
5 as possible to execute in low cost and possibly low performance AP.

Furthermore, the method is protocol-independent and so flexible that all the configuration may be done in
10 external configuration program and the Access Point does not need to know anything about the processed traffic.

Further advantageous developments are set out in the dependent claims.

15 In particular, the predetermined position in the frame is defined by the offset of the bit pattern in the frame. Thus, the position of the bit pattern to be extracted and examined can accurately be defined.

20 Furthermore, the offset and the search pattern are included in an information element. This information element can be produced by an external program such that the device according to the invention and the device
25 performing the method according to the invention does not have to generate the search pattern and the offset. Thus, the structure of the device does not have to be complex.

In addition, in case new protocols or modified protocols
30 are introduced in the network, it is not necessary to reconfigure the network element (i.e., the device) performing the method. It is only necessary to provide new information elements including the new offset and the new search pattern, which can be effected by an external
35 configuration program. For this, it is not necessary to

install new software in the network element or to install new hardware. It is not even necessary to shut down the network element for a new configuration. Hence, the method is very flexible.

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Moreover, the bit pattern can be masked by using a mask. Then, the masked bit pattern is compared with the search pattern instead of comparing the bit pattern (BP2) with the search pattern. By this measure, single bits can easily be extracted from the bit pattern. This is advantageous in case the bit pattern is extracted in form of bytes. For example, a bit pattern can include two bytes, whereas for the priority detection only two bits of each byte are required. These two bits can easily be extracted by using the mask.

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The mask can also be included in the information element described above.

If necessary, also a plurality of different bit patterns, search patterns, offsets and - optionally - masks can be used to detect priority of the frames. By this measure, a priority information can be detected which is located at different position within a data frame.

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Alternatively, a plurality of different priority levels can be provided for the frames. For detecting different priority levels, a plurality of different bit patterns, search patterns, offsets and - optionally - masks can be used to detect the plurality of different priority levels. By this measure, also different priority levels can easily be detected.

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Hence, a plurality of different information elements can be used. For example, one certain priority can require a

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plurality of information elements, while another certain priority can require only one particular information element.

- 5 A received frame can be forwarded to a priority queue in case the frame is detected to be a priority frame during a special period for sending priority traffic. The priority queue serves to transmit the data priority frames in the network faster than normal frames. This
10 measure is especially advantageous in an IEEE 802.11 WLAN since in this standard, a Contention Free Period is defined, as described above.

In addition, the duration of the special period for
15 sending priority traffic can be adjusted according to statistic information regarding the sent priority frames. Thus, the special period, i.e., the Contention Free Period, can be adjusted corresponding to the load of priority traffic on the network.

- 20 Furthermore, for obtaining the statistic information, the total number of priority frames and the number of priority frames outside the special period can be counted. Then, it can be decided on the basis of the
25 count values obtained whether the special period has to be increased or decreased.

In addition, in the IEEE 802.11, a data+CF-poll frame is defined. Preferably, this data+CF-poll frame can be used
30 for transmitting priority frames in case of a symmetrical high priority traffic between the Access Point and stations in the network.

- Furthermore, the invention proposes a method for
35 generating priority detecting information necessary for

the above method and device This method comprises the steps of analysing a data frame, identifying a bit pattern indicating a priority state, defining said identified bit pattern as a search pattern, and locating
5 said bit pattern within said data frame. By this method, the necessary priority detection information can easily be provided. For example, this method can be employed by a configuration program that is externally run, for example, in one of the wireless stations which are
10 connected by air with the Access Point (AP).

The above method for generating priority detecting information may further comprise the steps of determining the offset of said location, and producing an information
15 element including said offset and said search pattern. Optionally, also the mask for masking the bit pattern mentioned above can be determined and included in the information element.

20

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more readily understood with reference to the accompanying drawings in which:

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Fig. 1 shows a main system overview;

Fig. 2 shows a process for checking priority of frames according to a first embodiment;

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Fig. 3 shows an example for a frame to be examined by the process according to the first embodiment;

Fig. 4 shows a frame priority detecting device according
35 to the first embodiment;

Fig. 5 shows an example of pattern matching with two different information elements according to a second embodiment;

- 5 Fig. 6 illustrates a flow chart of a frame sending procedure during Content Free Period (CFP) according to the second embodiment;

Fig. 7 shows relevant parts of a Point Coordinator (PC)
10 according to a third embodiment;

Fig. 8 illustrates a flow chart of a frame sending procedure during Content Free Period (CFP) according to the third embodiment;

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Fig. 9 illustrates a flow chart of a frame sending procedure during contention period according to the third embodiment; and

- 20 Fig. 10 illustrates a flow chart of a procedure for CFP parameter tuning according to the third embodiment;

Fig. 11 shows a flow chart of a method for obtaining priority detection information; and

25

Fig. 12 illustrates the relationship between Content Free Periods (CFP) and Content Periods (CP) according to IEEE 802.11.

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DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following, preferred embodiments of the invention are described in more detail with reference to the
35 accompanying drawings.

Fig. 1 shows an overview of the main system used in the embodiments. The system is a normal IEEE 802.11 Basic Service Set (BSS) containing one Access point (AP) 2 and one or more wireless stations (STA) 3 to 5. The AP may or may not be connected to an other wired or wireless network 1. The purpose of the AP 2 is to transmit the traffic between the wireless stations or between wireless stations and the network 1 which is connected to the AP 2.

All the network components function according to the IEEE 802.11 standard. This presented set-up is a typical representation of the coverage area of one AP. The whole wireless network usually consists of several of these kinds of subsystems. An external configuration program may run in one of the stations in the wireless network or it may reside in some other host and be connected to AP with the wire. In this example, the configuration program is executed in the wireless station 3.

In the following, a first embodiment which shows the basic idea of the invention is described with respect to the flow chart shown in Fig. 2 and an example for a Medium Access Control (MAC) layer frame shown in Fig. 3.

The procedure shown in Fig. 2 is executed by the Access Point AP 2 every time a Medium Access Control (MAC) layer frame has been received.

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In step S1, the AP 2 extracts a bit pattern from a given position in the received frame. The bit pattern can be a pattern of two bytes, for example. However, the length of the bit pattern can be selected arbitrarily. The extracted bit pattern is indicated by BP in Fig. 2. In

step S2, the extracted bit pattern BP is compared with a predetermined search pattern SP. If in step S3 it is decided that both patterns match, it is determined in step S4 that the actual frame is a priority frame. On the other hand, if it is decided in step S3 that both patterns do not match, it is determined in step S5 that the actual frame is not a priority frame. After identifying the priority of the frame, the frame can be treated according to the identified priority.

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Thus, the frame can easily be examined whether it is a priority frame or not without the need for analyzing the data format in the MAC layer frame itself, i.e., without knowing protocols of the higher layers.

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The position of the bit pattern to be extracted is defined by the offset OS from the start of the MAC frame, as shown in Fig. 3. Thus, the AP 2 requires only information regarding the offset OS and the search pattern SP for checking priority of certain MAC frames.

20

This information can be provided by an external configuration program. The configuration program can be executed in one of the wireless stations, for example. Alternatively, it can be executed in any suitable network element, including the Access Point itself. For this configuration program it is necessary that the bit positions of the priority information which are usually set in higher layers are known. Thus, by providing the AP with the offset, the AP does not have to process the frame in order to identify priority information. It is only necessary to obtain the corresponding bit pattern.

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In the first embodiment, the configuration program is executed in the wireless station STA 3. The configuration

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program produces information elements which contain the above-described information regarding the offset OS and the search pattern SP necessary to identify the priority state of certain MAC frames. These information elements
5 are transmitted to the AP 2.

Fig. 4 shows the relevant parts of the Access Point 2 in more detail. Reference numeral 22 denotes a frame receiver by which frames are received from the wired or
10 wireless network 1 and also from the wireless stations 2 to 5. Reference numeral 23 denotes a bit pattern extractor by which the bit pattern BP described above is extracted from a predetermined position. The position is defined by the offset OS, as mentioned above, and the
15 offset is stored in an offset memory 27 which is accessed by the bit pattern extractor 23. The extracted bit pattern BP is forwarded to a comparator 24 which compares the extracted bit pattern BP with the search pattern SP. The search pattern SP is stored in a search pattern
20 memory 25 which is accessed by the comparator 24. The comparison result is supplied to a priority identifying means 26 which identifies the actual frame F as a priority frame in case the comparison results indicates that the bit pattern BP matches the search pattern SP.
25 Thus, the Access Point (AP) 2 can detect priority frames and can treat them correspondingly.

As mentioned above, the external configuration program provides information elements which each comprise an
30 offset OS and a search pattern SP. These information elements are received by an information element receiver 28. The receiver 28 analyzes the information element and supplies the detected offset OS to the offset memory 27 and the detected search pattern SP to the search pattern
35 memory 25.

The first embodiment described above illustrates the basic operation according to the invention. The second embodiment described in the following describes a further, more detailed example for the high priority traffic detection method in which the Content Free Period (CFP) defined in IEEE 802.11 standard is used for transmitting detected high priority frames.

10 According to IEEE 802.11, the Content Free Period (CFP) is a period which is reserved for transmitting high priority traffic, as described above in the introductory part with respect to Fig. 12. The CFP is controlled by a Point Coordinator (PC) 21 which is arranged in the Access
15 Point (AP) 2 shown in Fig. 1. If the high priority traffic is transferred only from the AP 1 to the wireless stations (i.e., in a typical client-server application case), the CFP may be used only for delivering data from the AP to wireless stations. But, if the nature of the
20 high priority traffic is interactive (like a videoconference, for example), the PC 21 must also poll wireless stations to permit them to transmit also during the CFP. See IEEE 802.11 standard for more detailed description about this basic functionality of IEEE 802.11
25 standard.

The AP 2 receives MAC layer frames either from the wireless station or from the connected wired network. If the destination of the frame is in the wireless network,
30 the AP will check if the frame is high or normal priority traffic. The priority detection requires that the AP 2 is configured with the external configuration program to detect the priority and the required configuration information elements are configured to the AP by the
35 external configuration program. The AP also needs to

reformat the MAC level header of the frame or encapsulate the frame inside a separate IEEE 802.11 MAC header which is defined in IEEE 802.11. The point when the priority detection check is performed (before or after IEEE 802.11
5 MAC header formatting) can be left implementation specific.

If the BSS is in a so-called Contention Free (CF) state (i.e., currently there is a Contention Free Period (CFP))
10 and the frame is a priority frame, the frame is put to a priority transmit queue, otherwise the frame is treated like the normal traffic. During the CFP, all the frames in the priority queue are transmitted before any frames from the normal queue. When the CFP ends, remaining
15 frames in the priority queue are moved to the normal queue and priority queue is flushed.

According to this embodiment, the priority of a MAC layer frame is detected by using one or more information
20 elements which are transmitted to the Access Point (AP)
1. That is, one or more bit patterns with corresponding different offsets are checked whether they match with one or more different search patterns. Furthermore, the bit patterns extracted from the MAC layer frame are also
25 masked by using a mask. The mask is also contained in an information element. Thus, the information element according to the second embodiment comprises the offset and the search pattern as according to the first embodiment, and in addition a mask. The mask serves to
30 obtain only particular bits in the extracted bit pattern and is optional.

The operation according to the second embodiment is described by referring to Figs. 5 and 6. It is noted that
35 for simplifying the illustration, the second embodiment

is described with reference to the case that the priority is detected by using two information elements.

In Fig. 5 it is shown that two bit patterns BP1 and BP2
5 are extracted from the MAC layer frame F. The first bit pattern BP1 is extracted with an offset OS1. As illustrated, the first bit pattern matches with the first search pattern SP1. For the first bit pattern BP1, no mask has been specified (i.e., no masking is performed).

10

However, for the second bit pattern BP1 a mask M2 is specified. In this example, the mask is M2 = 00010000 such that only the fourth bit is passed through. The resultant bit pattern BP2' is then compared with the
15 second search pattern SP2. Here, the second search pattern SP2 and the masked bit pattern BP2' match. Since also the first search pattern SP1 matches with the first bit pattern BP1, it is decided that the actual frame F is a high priority frame.

20

According to the second embodiment, the frame F which has been detected as a priority frame, is transmitted in the Contention Free Period (CFP). That is, it is put on a high priority queue. This process is described in the
25 following by referring to the flow chart shown in Fig. 6.

The process shown in this flow chart is performed during the Content Free Period, i.e., in case the CFP is active. In step S61, the Access Point (AP) 2 waits for receiving
30 a frame which is to be transmitted further to the wireless stations 3 to 5 (Fig. 1). In step S62, the bit patterns BP1 and BP2 are extracted from the frame F, as shown in Fig. 4. In step S63, the bit pattern BP2 is masked with the mask M2 to obtain a bit pattern BP2', as
35 described above. Since no mask has been specified for the

first bit pattern BP1, no corresponding step for the first bit pattern BP1 is performed.

Then, in step S64, it is checked whether both bit
5 patterns BP1 and BP2' match with the search patterns SP1 and SP2, respectively. If SP1 and BP1, and SP2 and BP2' respectively match, it is decided that the received frame F is a high priority frame, and the frame F is put to the priority queue (step S65). This is effected by the Point
10 Coordinator (PC) 21 arranged in the Access Point (AP) 2. If the patterns do not match (NO in step S64), the received frame F is put to the normal queue, as shown in step S66.

15 As described above, the Point Coordinator (PC) 21 puts a priority frame in the priority queue in case the Contention Free Period (CFP) is active. However, in case the CFP is inactive, the frame must go to normal queue so that it does not have to wait the CFP to start. When the
20 CFP starts, the PC flushes the normal queue and places the unsent high priority frames to the priority queue. Thus, when the Point Coordinator (PC) 21 notices that the frame which should be sent is a high priority frame, it puts this frame in the normal or high priority queue
25 depending on the current state of the network.

As mentioned above, the use of two information elements is only an example. The number of the information element can be more than two. By using a plurality of information
30 elements, it is also possible to distinguish between different priority levels. For example, the configuration program can give the following data to the Access Point by which three priorities (i.e. priority 1, priority 2 and priority 3) can be distinguished. It is noted that
35 these three priorities can each represent different

priority levels (e.g., priority 1 represents the highest priority while priority 3 has the lowers) or can represent equal priority levels.

5 Priority 1 information:

Information element 1: offset 1 and search pattern 1

Information element 2: offset 2 and search pattern 2

Information element 3: offset 3 and search pattern 3

...

10 Information element n: offset n and search pattern n

Priority 2 information:

Information element 1: offset 1 and search pattern 1

15 Priority 3 information:

Information element 1: offset 1 and search pattern 1

Information element 2: offset 2 and bit pattern 2

The AP then checks whether a received frame matches with
20 all the information elements of the first group
containing the information elements for priority 1. That
is, for each information element it is checked whether a
bit pattern at the offset included in the information
element matches with the search pattern included in the
25 information element. If this is the case for all
information elements, then the frame has the priority 1.

If the frame does not match with all information elements
listed in the first group, then the AP tests the same
30 frame with all the information elements (one, in this
example) of the second group containing the information
elements for priority 2. If the bit pattern extracted at
the offset 3 in the frame matches with the search pattern
3 included in information element 3, it is decided that
35 the frame has the priority 2.

However, if the patterns do not match, then the AP checks the priority 3 information. That is, the frame is checked whether it matches with information elements 1 and 2. If
5 this is the case, the frame has the priority 3. If the frame still does not match, it has no priority.

Next, a third embodiment is described, according to which the Point Coordinator (PC) 21 collects statistics about
10 the sent high priority traffic and adjusts the parameters for the CFP.

In detail, the PC 21 counts the high priority packets during the every so-called Delivery Traffic Indication
15 Message (DTIM) interval (see IEEE 802.11 WLAN standard). Furthermore, it also counts how much of those packets are transmitted outside the CFP and how much during the DTIM interval containing CFP but outside CFP. The PC saves statistics of the previous N DTIM intervals, where N is
20 at least CFP repeating interval. The PC then checks the statistics after every DTIM interval that contains CFP and adjusts the CFP length and interval accordingly. The frame handling and statistics collection during the CFP is presented in Fig. 8 and during the contention period
25 in Fig. 9.

The PC 21 according to the third embodiment is shown in Fig. 7 in greater detail. As derivable therefrom, the PC comprises a plurality of counters which are used by a PC
30 controller 211 to control the CFP. A priority frames counter (PFC) 212 serves to count all priority frames received. A counter for priority frames outside CFP (PFOCFP) counter 213 serves to count all priority frames which are received during the content period, i.e., when
35 CFP is inactive. A CFP DTIM counter 214 serves to count

all priority frames which are received in an DTIM interval containing a Contention Free Period (CFP). As mentioned above, The PC 21 forwards the received priority frames either to the normal queue 215 or to the priority queue 216 depending on the current state of the network.

The flowchart shown in Fig. 8 is almost the same as in Fig. 6. The steps S81 to S86 correspond to the steps S61 to S66 of Fig. 5. Thus, an unnecessary repetition is omitted here. However, in addition to the flow chart shown in Fig. 6, a new step S87 is performed in case patterns SP1 and BP1, and SP2 and BP2' match. In this step S8, the priority frame counter (PFC) 212 is incremented each time it is decided that an actual frame is a high priority frame.

Fig. 9 shows a flowchart representing a process performed during the content period, i.e., when the CFP is inactive. Here, all received frames are put in the normal queue. In case of a high priority frame, several values are counted by the counters of the Point Coordinator (PC) 21 for providing statistic information.

In detail, in step S91 it is waited for a frame, similar to step S81 of Fig. 8. In step S92, the priority is detected in the way as described in the first or second embodiment. If the actual frame is a normal frame with no priority, the flow advances to step S97 in which the frame is put to the normal queue 215. If, however, the actual frame is a priority frame, the flow advances to step S93 in which PFOCFP counter 213 is incremented. Furthermore, in step S94 also the priority frames counter 212 is incremented.

In step S95 it is checked whether the actual DTIM interval contains a Content Free Period (CFP). If this DTIM interval contains a CFP, the CFP DTIM counter 214 is incremented in step S96 before the flow advances to step 5 S97. Otherwise, the flow advances directly to step S97. Thereafter, the routine is ended.

The statistic information regarding the priority frames are used as described in the following with reference to 10 Fig. 10.

As shown in Fig. 10, the procedure is started in an DTIM interval after the end of the Content Free Period (step S101). In step S102, the percentage of priority frames 15 sent outside of the CFP is checked. Depending on the result, different processes are executed, as described next.

If the percentage of high priority traffic sent outside 20 of CFP is higher than a certain high alarm level HAL, the PC 21 will start corrective actions. These processes are illustrated on the right side of the flow chart shown in Fig. 10.

25 The alarm level is 100% - percentage of the high priority traffic that must be send inside the CFP in any case. For example, if it is known that the traffic which requires an almost real-time treatment requires a priority traffic of 30%, the alarm level is set to 70%. The alarm level 30 can be fixed or it can be dynamically adjustable.

When the alarm level HAL is reached, the PC will next check the percentage of high priority traffic sent during the DTIM intervals not containing the CFP. This is 35 effected in step S107 in which the difference between the

count values of the PFOCFP counter 213 and the CFP DTIM counter 214 is calculated, wherein the difference is brought in relation to the value of the priority frames counter (PFC) 212. If it is more than the alarm level
5 HAL, the PC will make the CFP interval to be half of the original (if it is not already one DTIM interval), as described in step S108.

Next, in step S109, the PC 21 will check if the
10 percentage of high priority traffic sent outside of the CFP during the DTIM intervals containing CFP is also higher than the alarm level. This percentage P is calculated as follows:

15
$$\text{CFP DTIM counter} / (\text{PFC} - (\text{PFOCFP} - \text{CFP DTIM counter})) / 100$$

If this percentage is higher than the alarm level, the PC 21 will double the duration of the CFP (if not already maximum possible) in step S1010. The alarm level used in
20 the different steps may be the same or different according to the wanted system behavior.

If it is decided in step S102 that the percentage of high priority traffic sent outside the CFP drops below a low
25 alarm level LAL, the PC 21 will start decreasing the CFP in order to give the normal traffic also a reasonable chance to be delivered in time. The low alarm level LAL is the percentage of the high priority traffic that can be send outside the CFP if needed. In order that the
30 system can work smoothly, the low alarm level should be less than 100% - high alarm level HAL.

When the alarm level LAL is reached, the PC 21 will next check what is the percentage of high priority traffic
35 sent during the DTIM intervals not containing the CFP in

step S103 which corresponds to step S107 described above. If it is less than alarm level, the PC will make the CFP interval to be double of the original in step S104. Next, the PC 21 will check if the percentage of high priority
5 traffic sent outside of the CFP during the DTIM containing CFP is also lower than the alarm level LAL. This is effected in step S105 which corresponds to step S109 described above. If this percentage is lower as the alarm level LAL, the PC 21 decreases the duration of the
10 CFP with amount of previous addition in step S106. The alarm level LAL used in the different steps may be the same or different according to the wanted system behavior.

15 If it is decided in step S102 that the percentage of priority frames outside the Content Free Period (i.e., the count value of the PFOCFP counter 213 with respect to the count value of the priority frame counter 212) is between the low alarm level LAL and the high alarm level
20 HAL, the flow advances directly to step S1011 in which all counters 212, 213 and 214 are reset. Then, the procedure is ended.

Next, a fourth embodiment is described. The structure and
25 procedures according to this embodiment is similar to the embodiments described above. However, in this embodiment the nature of the high priority traffic is checked. In particular, it is considered whether the high priority traffic is symmetrical, i.e., whether the high priority
30 traffic from a wireless station to the Access Point (AP) 2 is the same or almost the same as the high priority traffic from the AP 2 to the wireless station.

During the Content Free Period (CFP) the wireless
35 stations (terminals) are not allowed to transmit unless

the PC 21 polls them. Therefore, they will register themselves to PC to be placed in a polling list. In order to get the best benefit from this traffic control, wireless stations in the WLAN must be able to identify
5 the high priority traffic and send that traffic during the CFP.

In case of the symmetrical high priority traffic between the AP 2 and the wireless stations, the configuration
10 information (from the external configuration program) contains a field telling that this is symmetrical high priority traffic. When the Point Coordinator (PC) 21 in the AP 2 detects that the high priority traffic is symmetrical and the receiving station is pollable during
15 the Content Free Period (i.e., is CF-pollable), it will send it to the terminal inside a so-called data+CF-poll frame instead of normal data frame during the CFP. The data+CF-poll frame is a special data frame, defined in the IEEE 802.11 standard, that allows the receiving
20 station send one data frame during the CFP after receiving the data + CF-poll frame. During the contention period, the symmetrical traffic does not cause any special processes. The use of data+CF-poll frame enables equal high priority data delivering performance to both
25 directions.

The PC 21 must ensure that other wireless stations in the polling list gets polled according to the standard even when delivering symmetrical high priority traffic.
30

In the following, the configuration program used for generating priority detection information used in the above embodiments is described in more detail.

The method adopted in the configuration program is described by referring to the flowchart shown in Fig. 11.

In step S111, a bit pattern (consisting, for example, of
5 one or two bytes) which indicates the priority
information is identified in the data frame. The
identified bit pattern is defined as the search pattern
(SP) in step S112. In step S113, the location, that is,
the offset of the identified bit pattern (i.e., the
10 search pattern) inside the data frame is determined.
Thereafter, an information element containing the
determined offset and the identified search pattern is
produced in step S114. Finally, in step S115 the
information element is sent to the Access Point and the
15 routine ends.

In a similar way, also the optional mask (as used in the
second embodiment) can be obtained. Therefore, an
additional step is required which is performed after the
20 bit pattern identifying step S112 such that the mask is
defined. It is also possible to produce a plurality of
information elements, as used in the second and third
embodiment, also by taking into account a plurality of
different priority levels.

25

Next, an example is described in which frames (containing
IP packets) to be sent to a particular IP-address should
have high priority. In this case, the identification of
the search patterns and the location of the search
30 patterns can be performed as follows: The configuration
program knows that the offset to the destination IP-
address from the beginning of the IP packet (as an
example for a data frame) is 32 bytes and the offset from
the beginning of the ethernet (version 2) frame to
35 beginning of the IP packet is 14 bytes. Thus, the actual

offset of the IP-address is 46 bytes. The search pattern is the IP-address in question. Thus, the necessary information for an information element can easily be extracted.

5

In other cases, it might be necessary that the configuration program analyzes frames in order to obtain the relevant information.

- 10 The location for performing the above method within the network can be arbitrarily chosen. It may be located in some station in the wireless network, it may be centralized in a place in the wired network, or it may be connected to the AP with a separate cable. In some cases,
15 the configuration program may also be run in the AP, but in this way the benefit of the configuration program being external will be lost.

- Preferably, the location where the above method, i.e.,
20 the external configuration program can be performed is in one of the wireless stations 2 to 5. In this way, the program can also "snoop" the traffic and check whether the traffic is correctly recognized by the AP, that is, whether the high priority traffic is correctly treated.
25 This is because in the wireless stations, the data sent with the frames are processed and, thus, it is clear whether a received frame is a priority frame or not.

- When placed in the WLAN, the configuration program can
30 also make corrections to the AP configurations (i.e., the information elements sent to the AP) based on a traffic monitoring in the WLAN. The configuration program can be run in some notebook PC in WLAN, for example.

In rather large networks, however, the best place for the configuration program is in the wired network, where all the access points of the network can be controlled with a single configuration program.

5

The above description and accompanying drawings only illustrate the present invention by way of example. Thus, the embodiments of the invention may vary within the scope of the attached claims. For example, the
10 embodiments can be arbitrarily combined.

In particular it has to be noted that the above description of the embodiment has been made basically with respect to the IEEE 802.11 WLAN standard. However,
15 it has to be noted that this is only an example and that it is to be understood that the invention can also be applied to other suitable network situations.

Furthermore, in the above embodiments it was basically
20 distinguished between priority frames and normal frames, i.e., between frames with priority and frames without priority. However, it is also possible to distinguish between a plurality of different priority levels. For example, the second embodiment can be modified such that
25 the two bit patterns are used to distinguish between three different priority levels (no priority - medium priority - high priority). Also, different masks for one bit pattern can be used to distinguish between different priority levels.

Claims

1. A method for detecting priority of data frames in a
5 network comprising the steps of
 extracting (S1) a bit pattern from a predetermined
 position in a frame,
 comparing (S2, S3) said extracted bit pattern (BP)
 with a search pattern (SP), and
10 identifying (S4) said received frame as a priority
 frame in case said extracted bit pattern (BP) matches
 with said first search pattern (SP).
2. The method according to claim 1, wherein said
15 predetermined position in said frame is defined by the
 offset (OS) of said bit pattern in said frame.
3. The method according to claim 2, wherein said offset
 (OS) and said search pattern (SP) are included in an
20 information element.
4. The method according to claim 1, further comprising
 the step of
 masking (S63) said bit pattern (BP2) by using a mask
25 (M2) and comparing the masked bit pattern (BP2') with
 said search pattern (SP) instead of comparing said bit
 pattern (BP2) with said search pattern (SP).
5. The method according to claim 4, wherein said
30 predetermined position in said frame is defined by the
 offset (OS2) of said bit pattern (BP2) in said frame, and
 said offset (OS2), said search pattern (SP2) and said
 mask (M2) are included in an information element.

6. The method according to claim 1, wherein a plurality of different bit patterns (BP1, BP2), search patterns (SP1, SP2) and offsets (OS1, OS2) are used to detect priority of said frames.

5

7. The method according to claim 1, wherein a plurality of different priority levels are provided and a plurality of different bit patterns (BP1, BP2), search patterns (SP1, SP2) and offsets (OS1, OS2) are used to detect said
10 plurality of different priority levels.

8. The method according to claim 1, further comprising the step of

forwarding (S65; S85) said received frame to a high
15 priority queue (216) in case said frame (F) is detected to be a high priority frame during a special period (CFP) for sending priority traffic.

9. The method according to claim 8, further comprising
20 the step of

adjusting (S101 to S1011) the duration of the special period (CFP) for sending priority traffic according statistic information regarding the sent priority frames.

25

10. The method according to claim 9, further comprising the steps of

counting (S94) the total number of priority frames;
counting (S93) the number of priority frames outside
30 said special period (CFP); and

deciding (S103, S107) whether said special period has to be increased or decreased on the basis of the count values obtained in said counting steps.

11. The method according to claim 1, further comprising the steps of

using a data+CF-poll frame defined in IEEE 802.11 for transmitting priority frames.

5

12. A device for detecting priority of data frames comprising

a receiving means (22) for receiving data frames (F);

10 an extracting means (23) for extracting a bit pattern (BP; BP1) from a predetermined position of a data frame (F); and

a comparing means (24) for comparing said extracted bit pattern (BP; BP1) with a predetermined search pattern

15 (SP; SP1); and

an identifying means (26) for identifying said received frame (F) as a priority frame in case said extracted bit pattern (BP) matches with said first search pattern (SP).

20

13. The device according to claim 12, wherein said predetermined position is defined by an offset (OS; OS1, OS2).

25 14. The device according to claim 13, wherein said offset (OS) and said search pattern (SP) are included in an information element.

15. The device according to claim 12, further comprising
30 a masking means for masking said bit pattern (BP2) by using a mask (M2), wherein said comparing means (24) compares the masked bit pattern (BP2') with said search pattern (SP) instead of comparing said bit pattern (BP2) with said search pattern (SP).

35

16. The device according to claim 15, wherein said predetermined position in said frame is defined by the offset (OS2) of said bit pattern (BP2) in said frame, and said offset (OS2), said search pattern (SP2) and said mask (M2) are included in an information element.

17. The device according to claim 12, wherein a plurality of different bit patterns (BP1, BP2), search patterns (SP1, SP2) and offsets (OS1, OS2) are used to detect priority of said frames.

18. The device according to claim 12, wherein a plurality of different priority levels are provided and a plurality of different bit patterns (BP1, BP2), search patterns (SP1, SP2) and offsets (OS1, OS2) are used to detect said plurality of different priority levels.

19. The device according to claim 1, wherein a controlling means (211) forwards said received frame to a high priority queue (216) in case said frame (F) is detected to be a high priority frame during a special period (CFP) for sending priority traffic.

20. The device according to claim 19, wherein said controlling means (211) adjusts the duration of the special period (CFP) for sending priority traffic according statistic information regarding the sent priority frames.

21. The device according to claim 20, wherein said controlling means (211), in order to obtain said statistic information, accesses to a priority frames counter (212) for counting (S94) the total number of priority frames and a counter (213) for counting priority frames outside said special period (CFP), said

controlling means (211) deciding whether said special period has to be increased or decreased on the basis of the count values obtained in said counting steps.

- 5 22. The device according to claim 12, further comprising a means for transmitting priority frames via a data+CF-poll frame defined in IEEE 802.11.

23. Method for generating priority detecting information
10 used in the method according to claim 1 or the device according to claim 12, comprising the steps of
 identifying (S111) a bit pattern indicating a priority state;
 defining (S112) said identified bit pattern as a
15 search pattern;
 and locating (S113) said bit pattern within said data frame.

24. The method according to claim 23, further comprising
20 determining (S113) the offset of said location; and
 producing (S114) an information element including said offset and said search pattern.

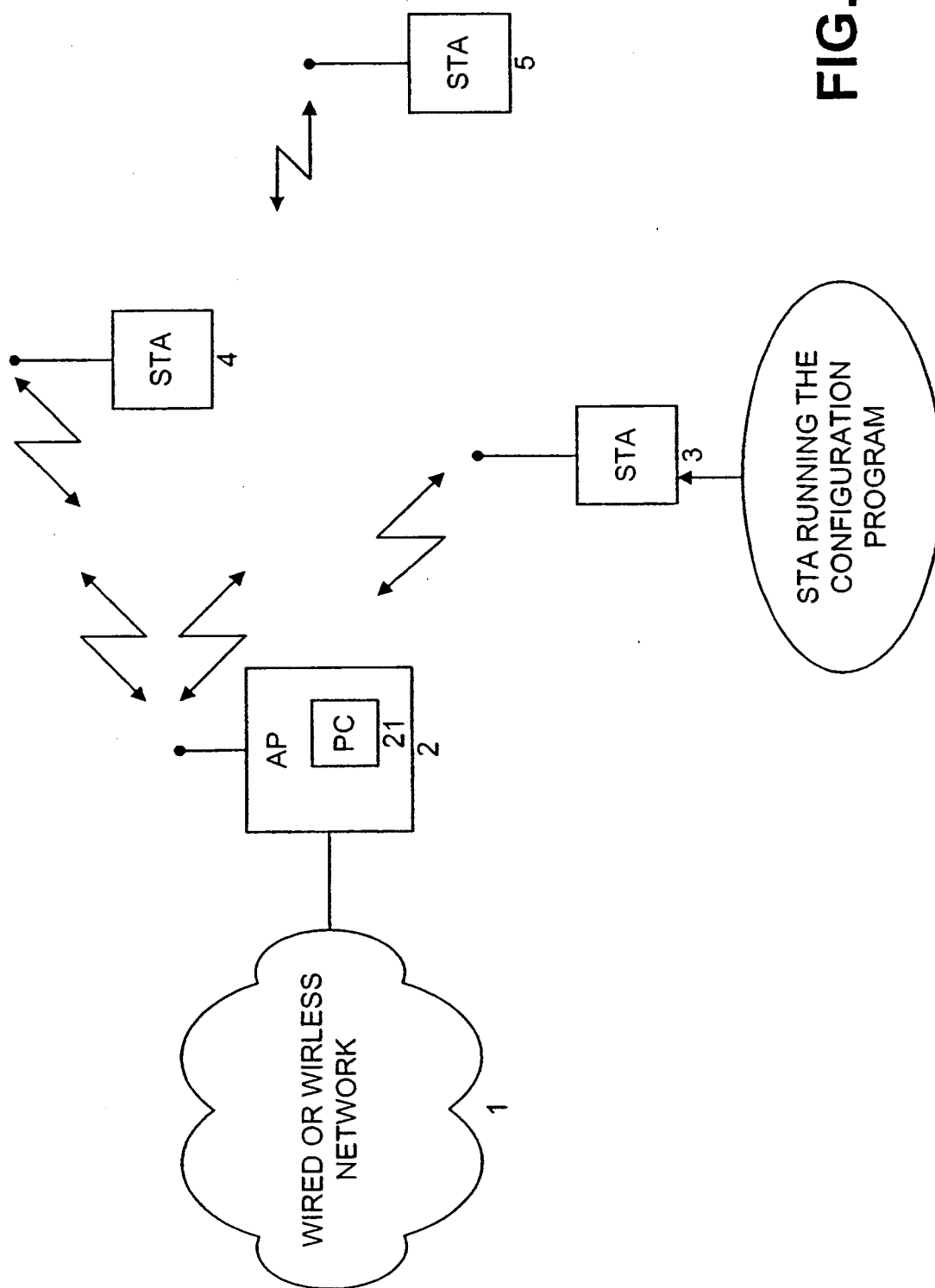


FIG. 1

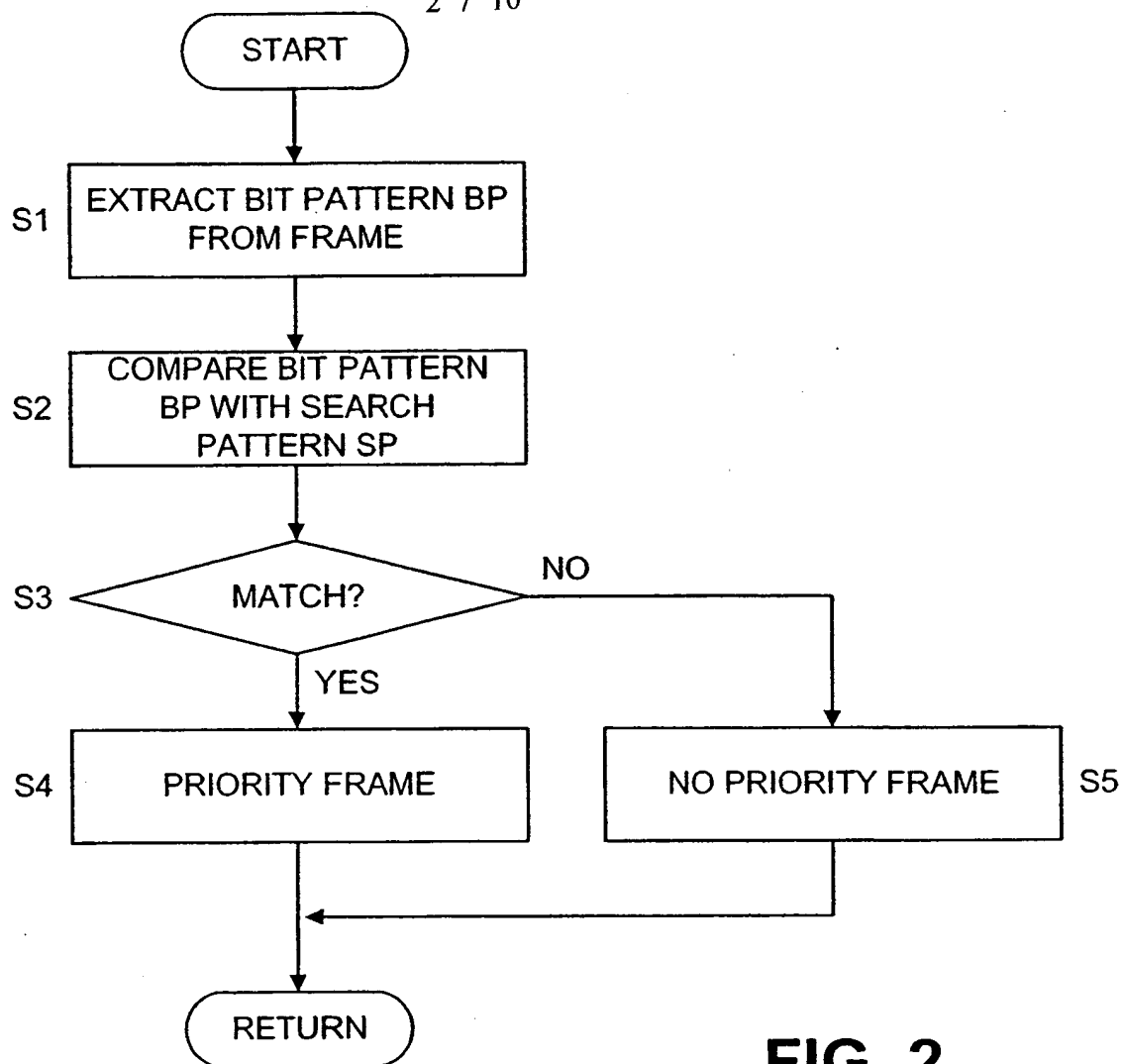


FIG. 2

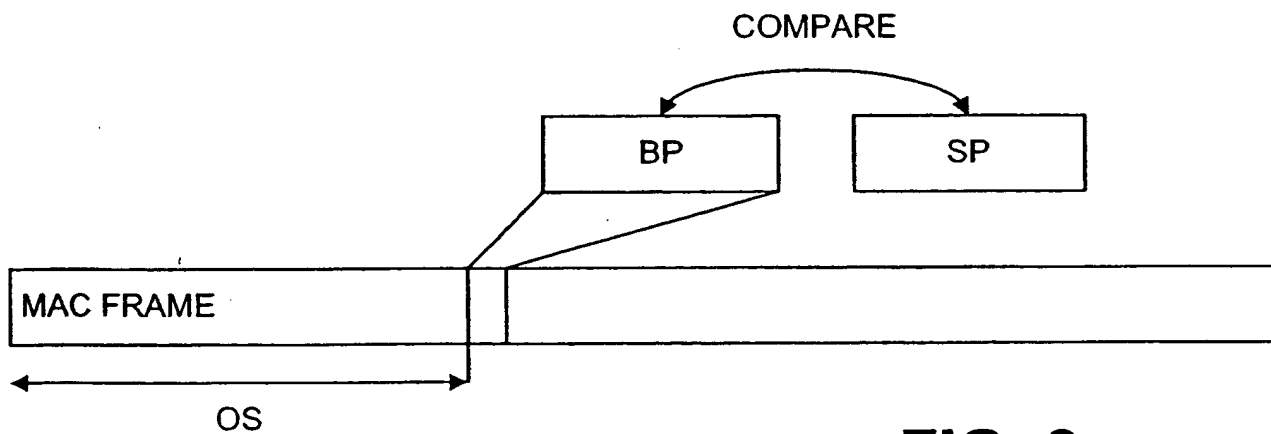
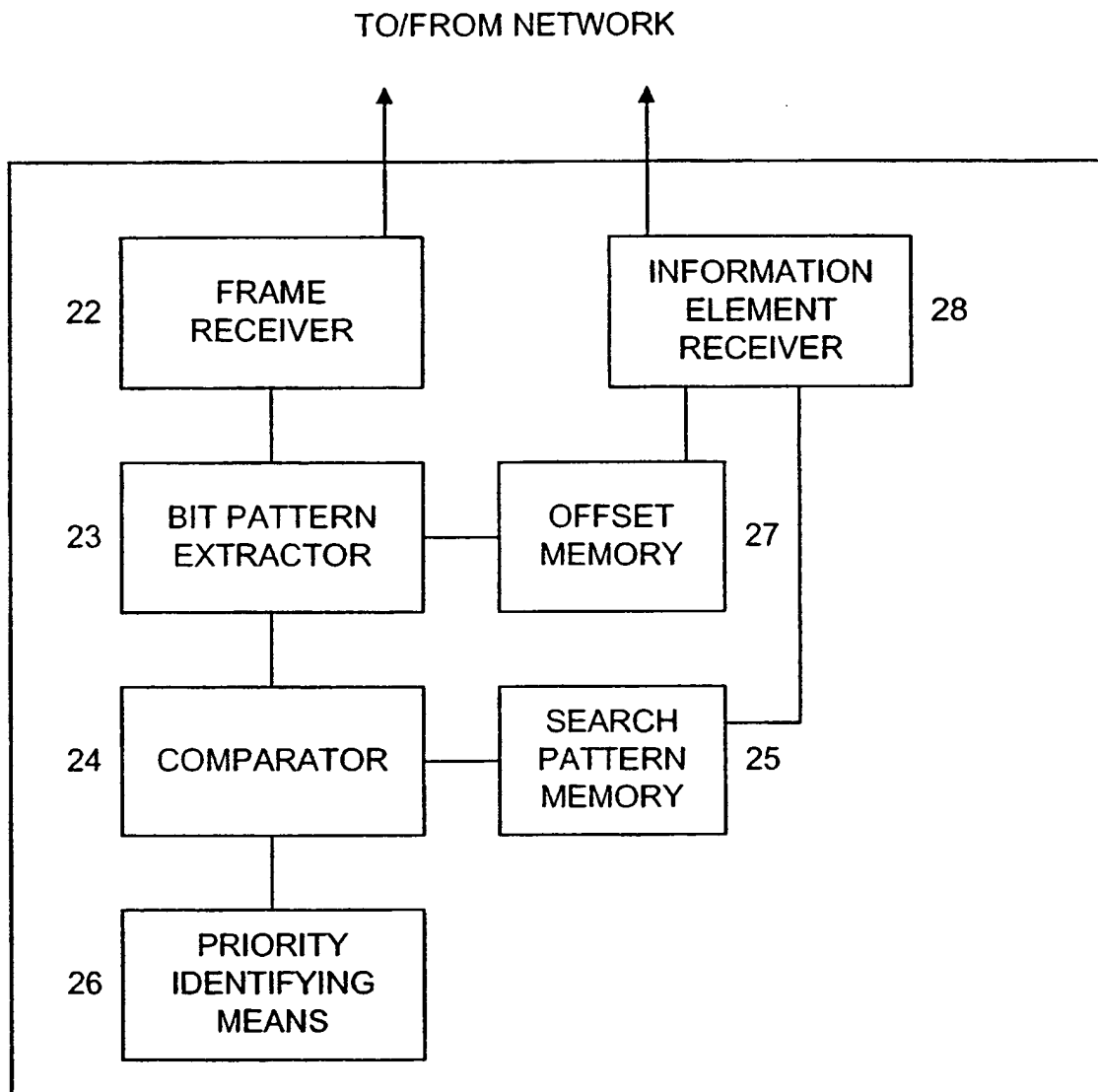


FIG. 3

**FIG. 4**

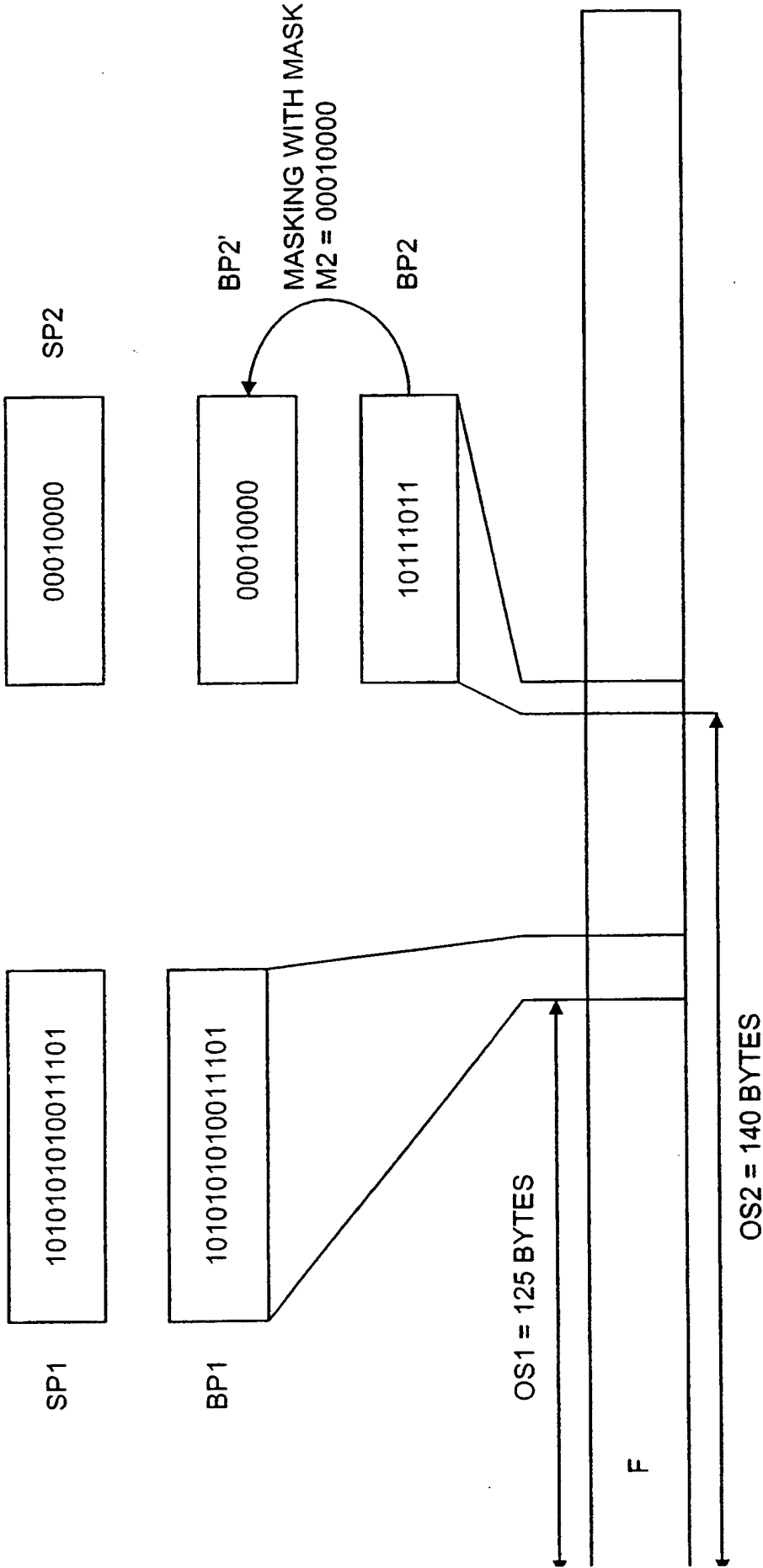
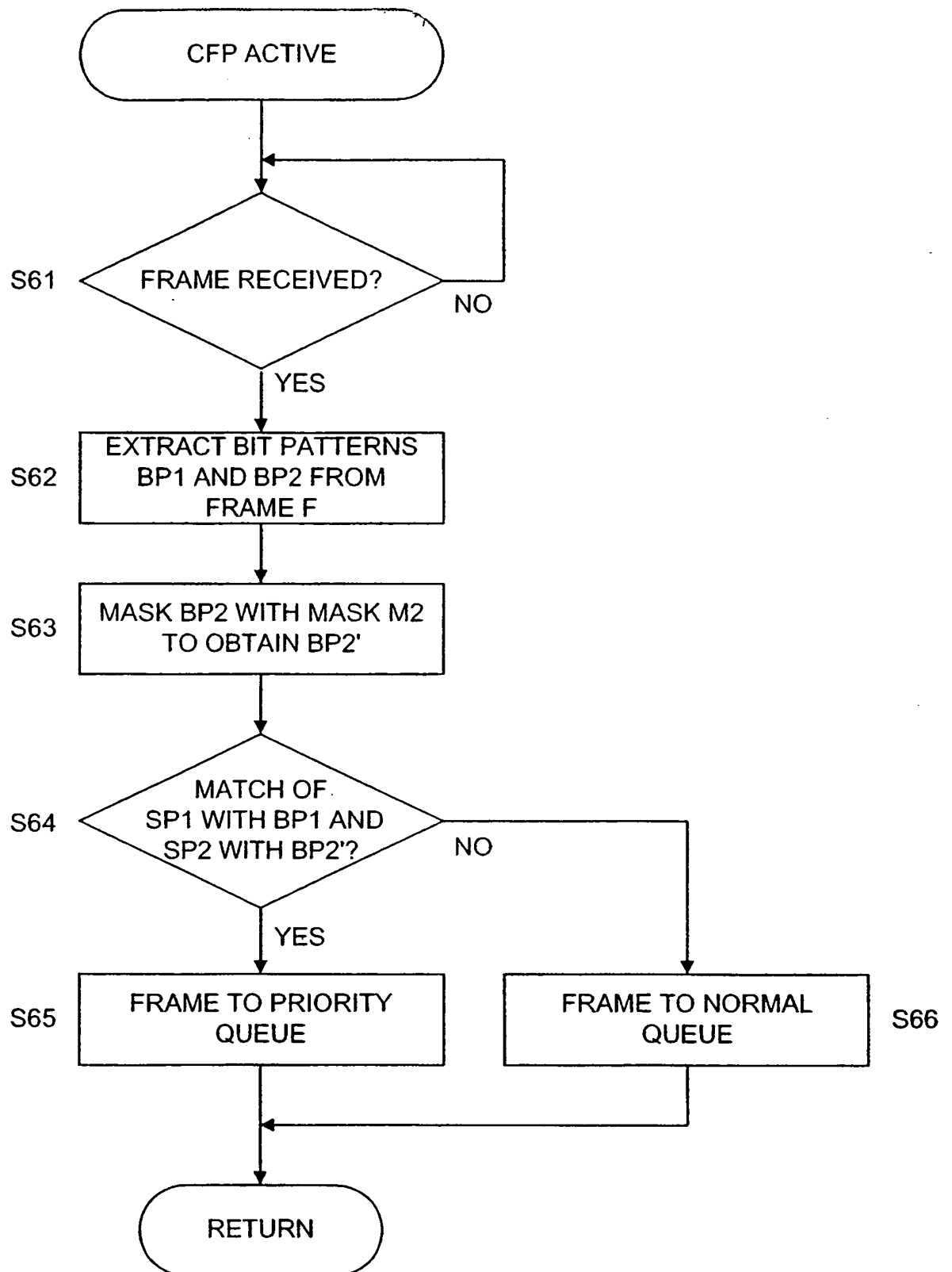
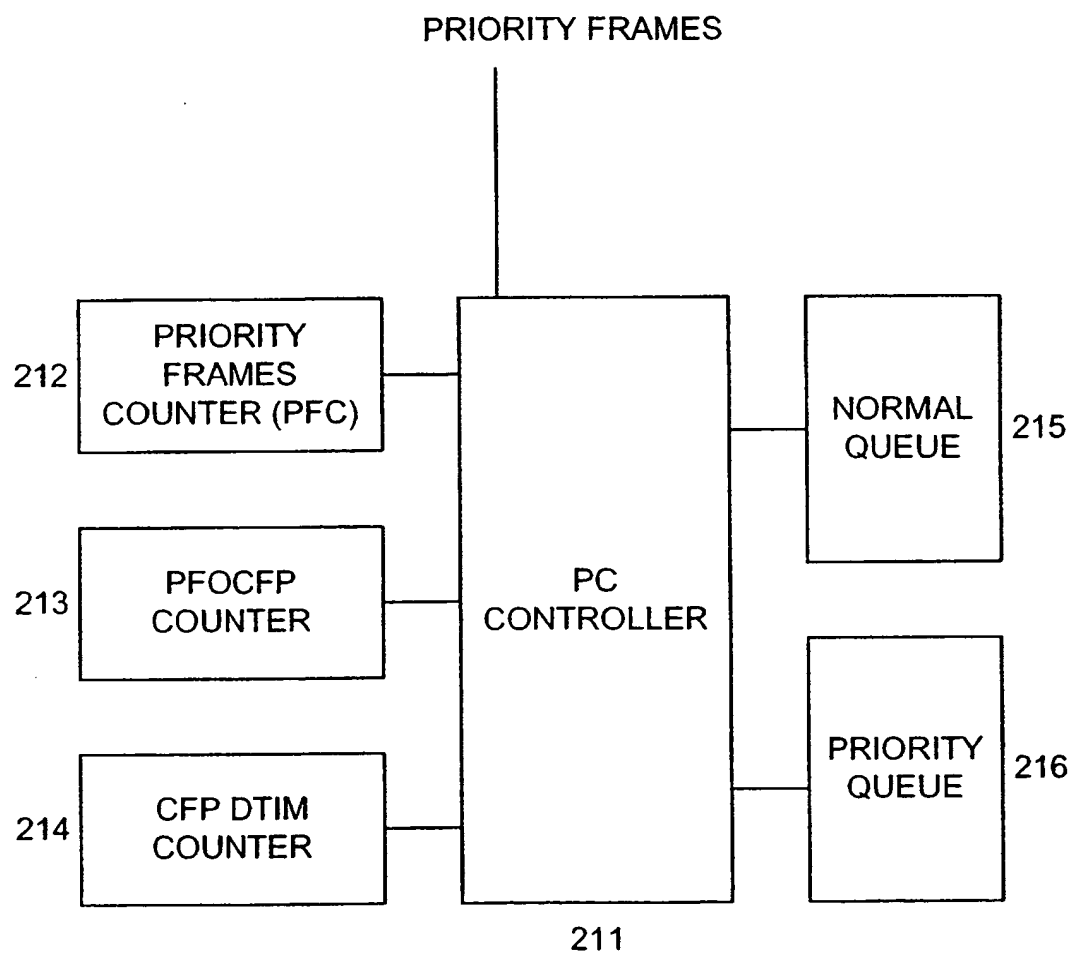


FIG. 5

**FIG. 6**

**FIG. 7**

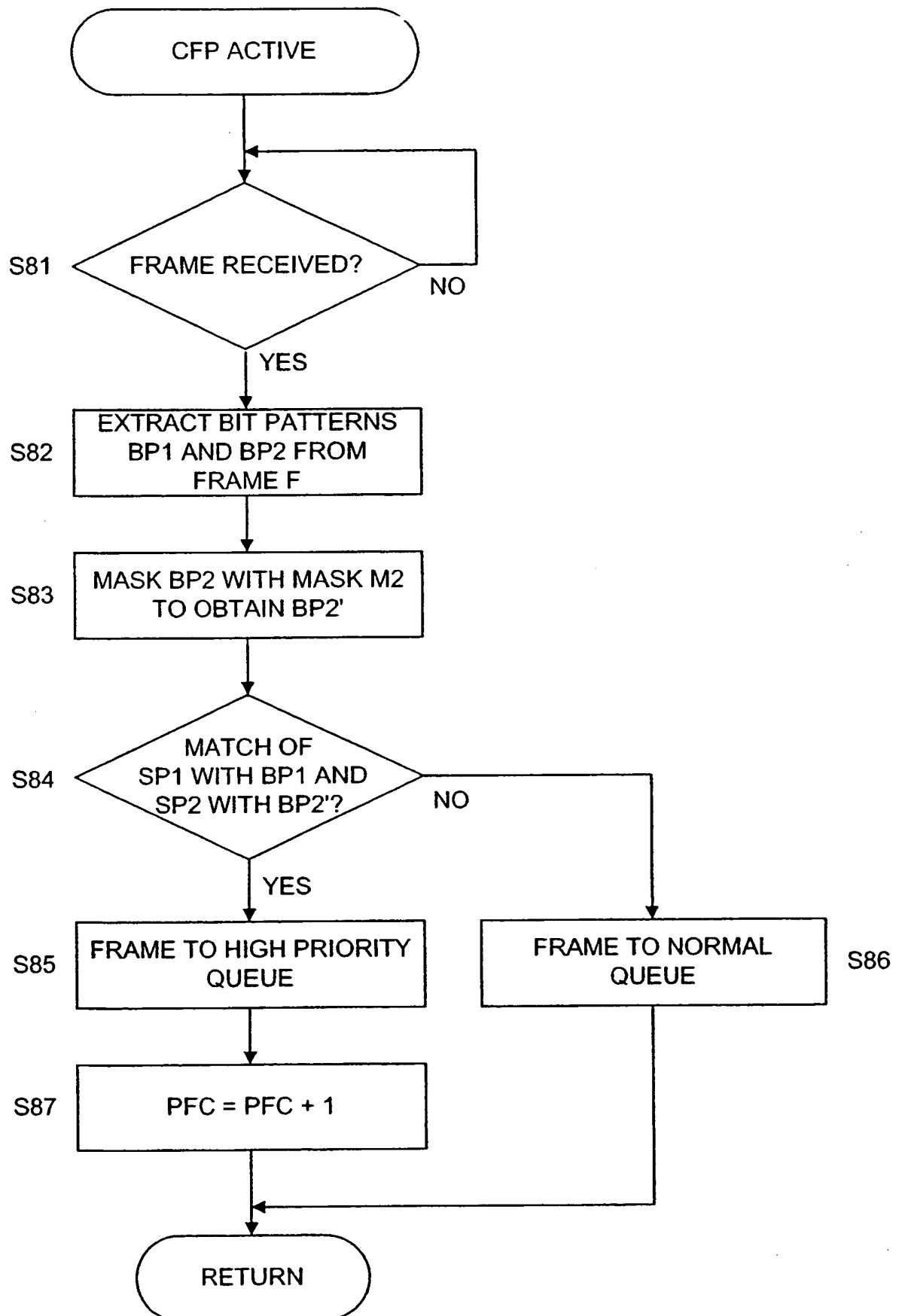


FIG. 8

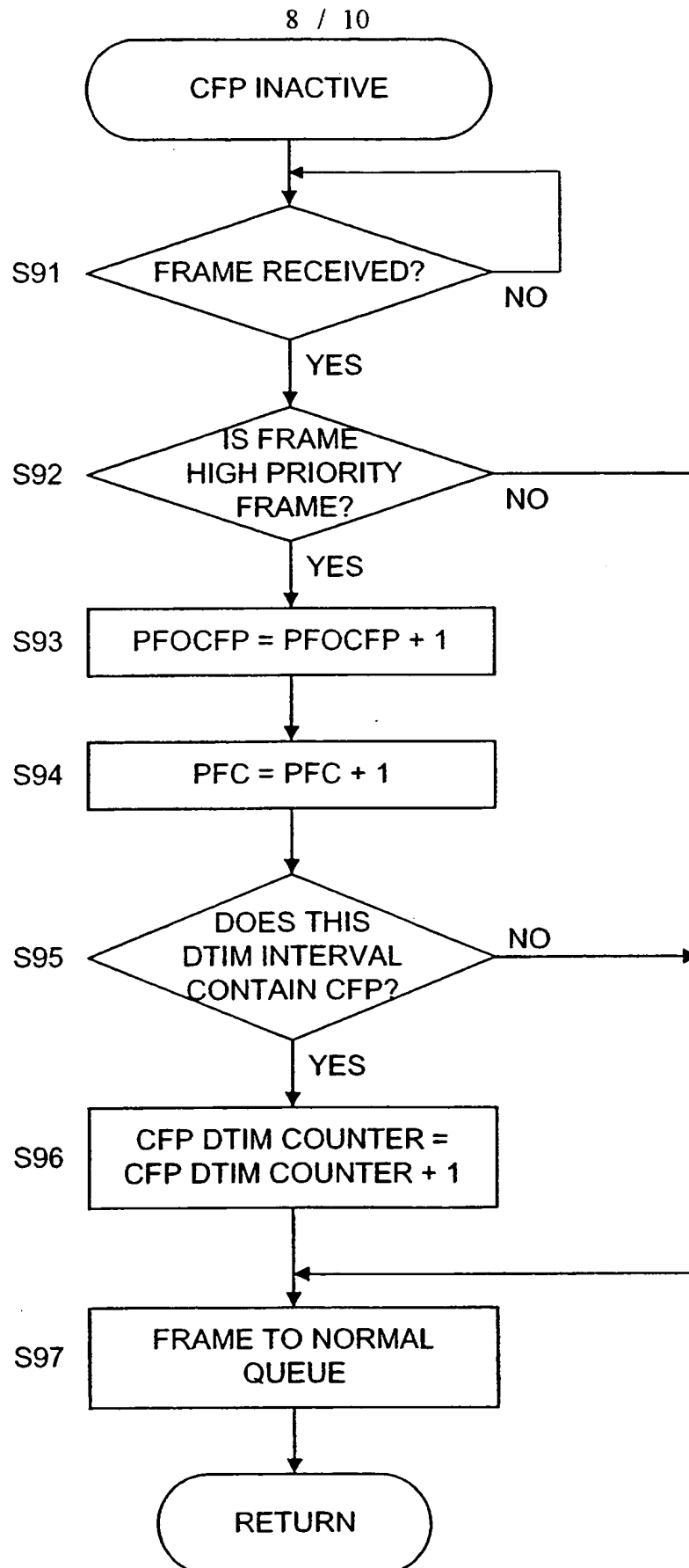
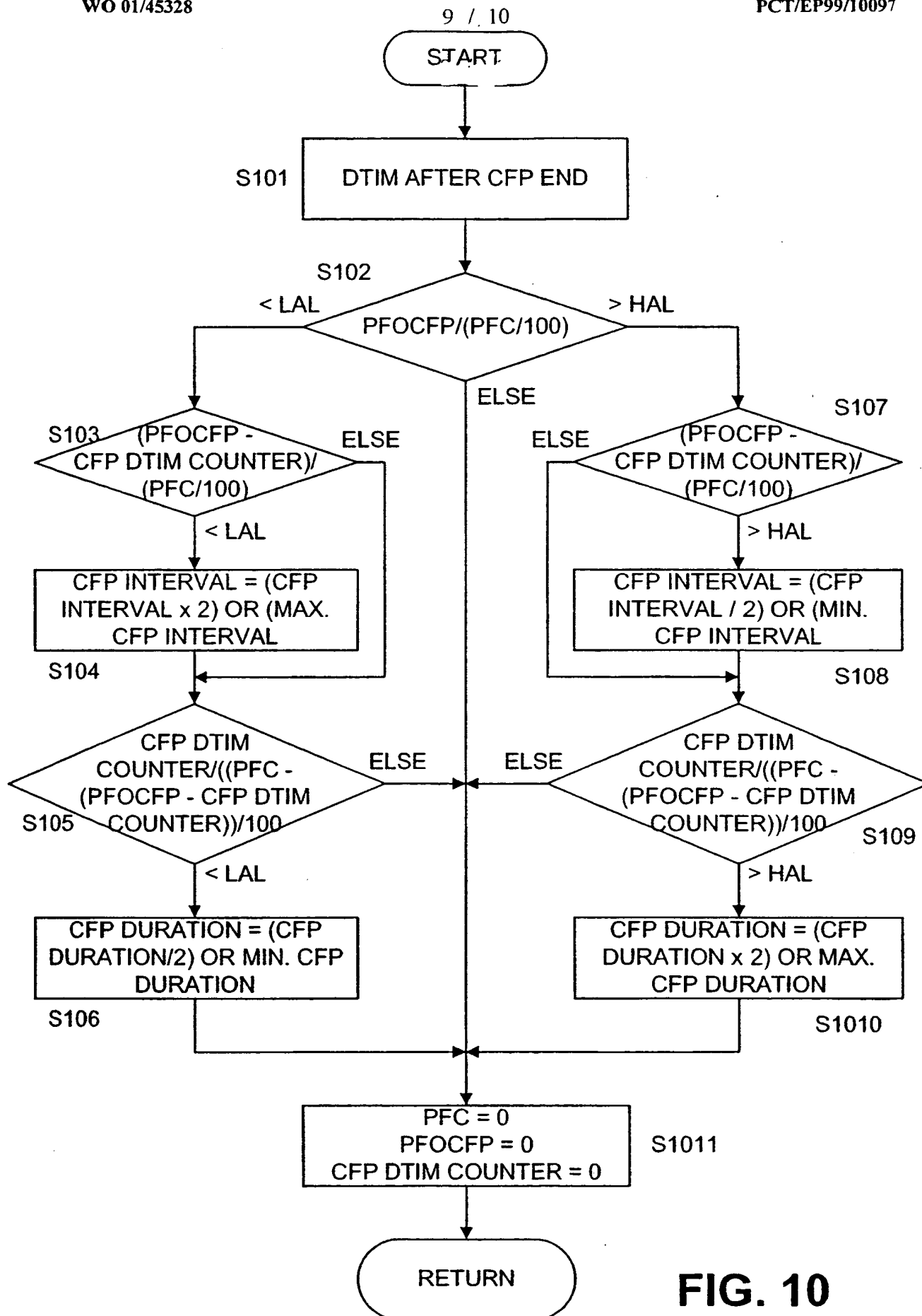
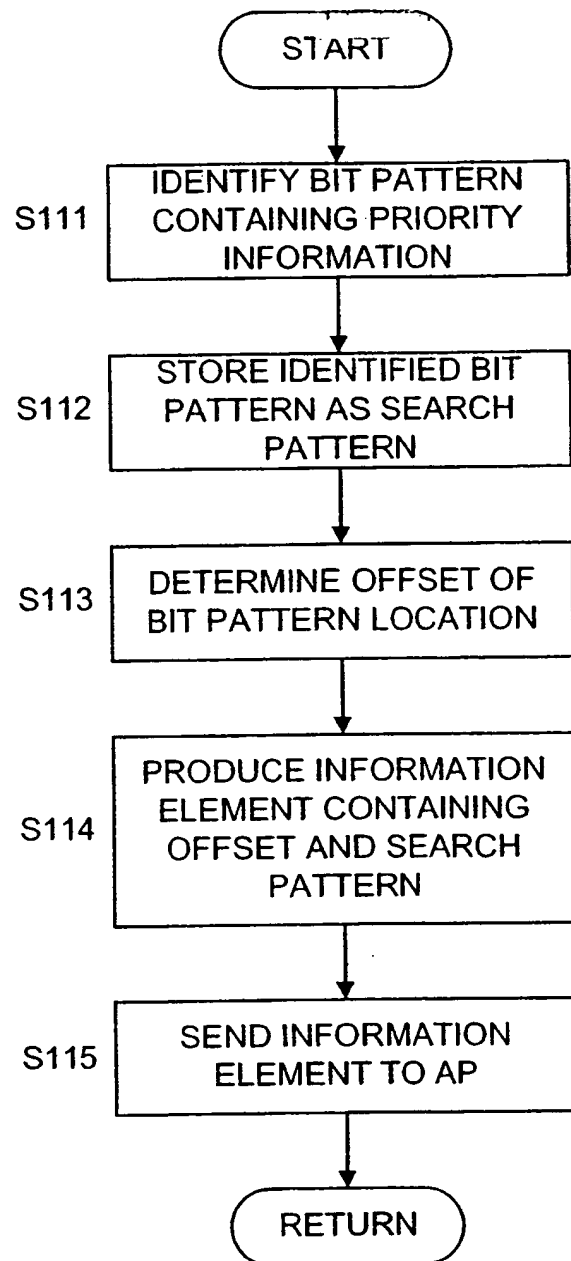
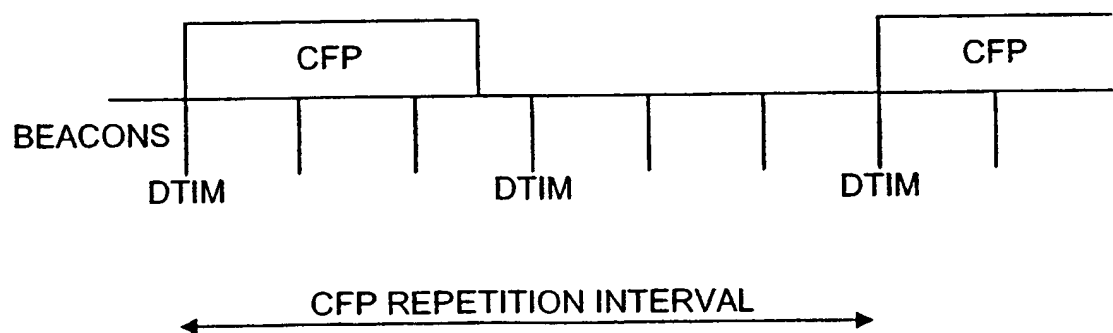


FIG. 9

**FIG. 10**

**FIG. 11****FIG. 12**

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 99/10097

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04L12/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

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Y A	----- -/--	4,15 11,22

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search

19 March 2001

Date of mailing of the international search report

02 04 2001

Name and mailing address of the ISA

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Authorized officer

Wickham V

INTERNATIONAL SEARCH REPORT

Inte. l. Application No

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 99/10097

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP 99/10097

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-5,11-16,22,
as far as relating to the first invention

A method for detecting the priority of a data frame, where a bit pattern is extracted from a frame, where said bit pattern is compared with a search pattern, where said frame is identified to have a certain priority if said extracted bit pattern matches said search pattern, and where said bit pattern is masked using a mask.

2. Claims: 1,6,7,12,17,18,23,24,
as far as relating to the second invention

A method for detecting the priority of a data frame, where a bit pattern is extracted from a frame, where said bit pattern is compared with a search pattern, where said frame is identified to have a certain priority if said extracted bit pattern matches said search pattern, and where said bit pattern could be located in a plurality of positions inside said frame.

3. Claims: 1,8-10,12,19-21,
as far as relating to the third invention

A method for detecting the priority of a data frame, where a bit pattern is extracted from a frame, where said bit pattern is compared with a search pattern, where said frame is identified to have a certain priority if said extracted bit pattern matches said search pattern, and where a received frame is placed in a high priority queue if said frame is identified as high priority frame during a special period for sending priority traffic.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 99/10097

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Information on patent family members

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